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ABSTRACT

This book consists of two complete units on astronomy. The first unit is created for lower elementary students and the second one is for upper elementary grade levels. The units are designed for gifted students and encourage students to be responsible for their own education. Each unit is based on an interdisciplinary approach. Suggestions for adaptation of the units are also included. (YDS)

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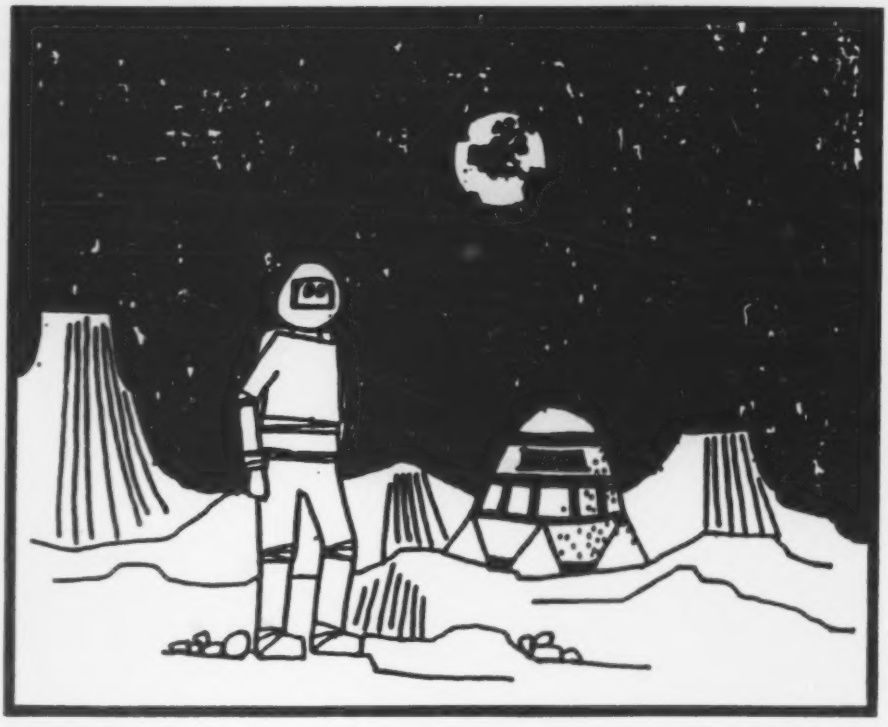
Exploring Beyond Earth



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A ZEPHYR LEARNING PACKET

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ASTRONOMY

Exploring Beyond Earth

by Carolyn Zolg

Self-directed study units
for grades K–3 and 4–8.

Process- and product-oriented
interdisciplinary learning through:

Evaluating
Imagining
Researching
Reporting
Thinking and reacting
Mapping and charting
Creating and appreciating
Classifying and comparing
Career exploration and goal clarification

Zephyr Press®
Reaching Their Highest Potential
Tucson, Arizona

ASTRONOMY
Exploring Beyond Earth

Grades K–8

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The Premise

LEARNING IS NATURAL

Children are active participants in their learning, not passive vessels to be filled.

They are always seeking and choosing what they will learn and what they will not learn.

Their interest, trust, and active involvement are crucial.

Children tend to become personally involved in projects that appeal to a variety of modalities . . . reading, writing, reasoning, building, imagining, and creating.

What a gift we give when we respect the child's natural need to explore, to reflect, to communicate, to dream, to celebrate!

(Available in poster form from Zephyr Press)

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A Word to the Teacher

ASTRONOMY

Astronomy is one of the oldest true sciences. From ancient times people have studied the heavenly bodies and their movements in space. In early days, people believed that planet Earth was the center of the universe, that the Earth was flat, and that the sky was a huge dome above. Ancient peoples used the celestial bodies to tell them the best time to begin a battle, where to build a pyramid, when to plant seeds for the best crops, and how to reach a distant land.

Today, the rapid development of technology has given us a new understanding of Earth, our solar system, and the universe. Space travel has allowed humanity to study Earth from space and to move beyond our planet to explore the nature of the universe. Yet many questions about the universe remain unanswered. In the future, astronomers may find new dimensions of outer space, intelligent life on other planets, or the answers to age-old questions about the beginnings of the universe and our planet, Earth.

Rationale for Self-directed Learning

Our children's education must be more than the memorization of capitals of the states, the products of countries, and dates and places of past wars. Most teachers and parents would agree that what is also wanted is for our children to learn to think for themselves, to make wise choices, to work independently, to thoughtfully evaluate the results of their study, and to use their knowledge and skills creatively.

Obstacles to Independent Learning

In spite of the teacher's best efforts, many, if not most, classroom programs involve students in schedules and organizational plans that foster dependence rather than the independence we prefer. Students are told what is to be learned and how long it will take them to learn it. The teacher not only defines the resources but also decides whether the learning experience was a satisfactory and valuable one.

A Learning Atmosphere

Each time we, as educators, focus on what our objectives are, we need to take a fresh look at our classroom mode of operation and evaluate the effectiveness of the way we teach. Quite naturally, for most of us, our teaching style has had more to do with how we were taught than with what recent research has shown about the learning process. Even our good instincts have been overcome by the years of conditioning we have known in our own educational processes.

Like a breath of fresh air, recent findings from research on the brain support our intuitive knowledge. This research shows that our brains are receptive to learning only under certain conditions. Our job is to translate that information into a classroom atmosphere that provides

- challenge
- freedom within structure
- trust and warmth
- recognition of each student's learning process
- opportunities to experience success
- personal involvement in the curriculum

A natural transition generally occurs that transforms the former "teacher-lecturer" into a "fellow learner." As fellow learner, the teacher becomes a resource person, a facilitator, and a classroom manager. In this maturing atmosphere, students gradually come to see themselves as responsible for their own learning, and a foundation for self-direction is set.

At this point, an unexpected problem sometimes arises. We find students no more ready for their independent learning than we, as teachers, were ready to allow it. This common occurrence is mentioned repeatedly in the literature dealing with programming for the gifted, an area in which independent study and research are recommended as major curricular activities. See Suggested Readings.

From Passive Learner to Active Participant

(Bridging the Gap)

The Zephyr self-directed study unit was developed expressly to bridge that gap: to transport the student from the position of passive recipient to that of an active participant in his/her own pursuit of knowledge.

Within the defined structure of each unit, students are given opportunities to

- make choices
- learn at their own paces
- learn in a manner suited to their own learning styles
- expand their research skills
- use a variety of modalities
- plan their own time
- develop the skills of creative, critical, and evaluative thinking
- experience whole-brain learning

Because assuming responsibility for directing their own learning is often an unfamiliar situation for students, they will need your encouragement at the start. Generally within six to nine weeks most students will be well on their way from teacher-dependence to self-motivation. (Beginning the venture with only a few choices, then gradually arranging the setting so that there are more and more choices works best.) As students assume more responsibility, many teachers begin to consider the school library as just another part of the classroom. The benefits are many, from gaining a personal relationship with the librarian to learning about the enormous resources available in most school libraries.

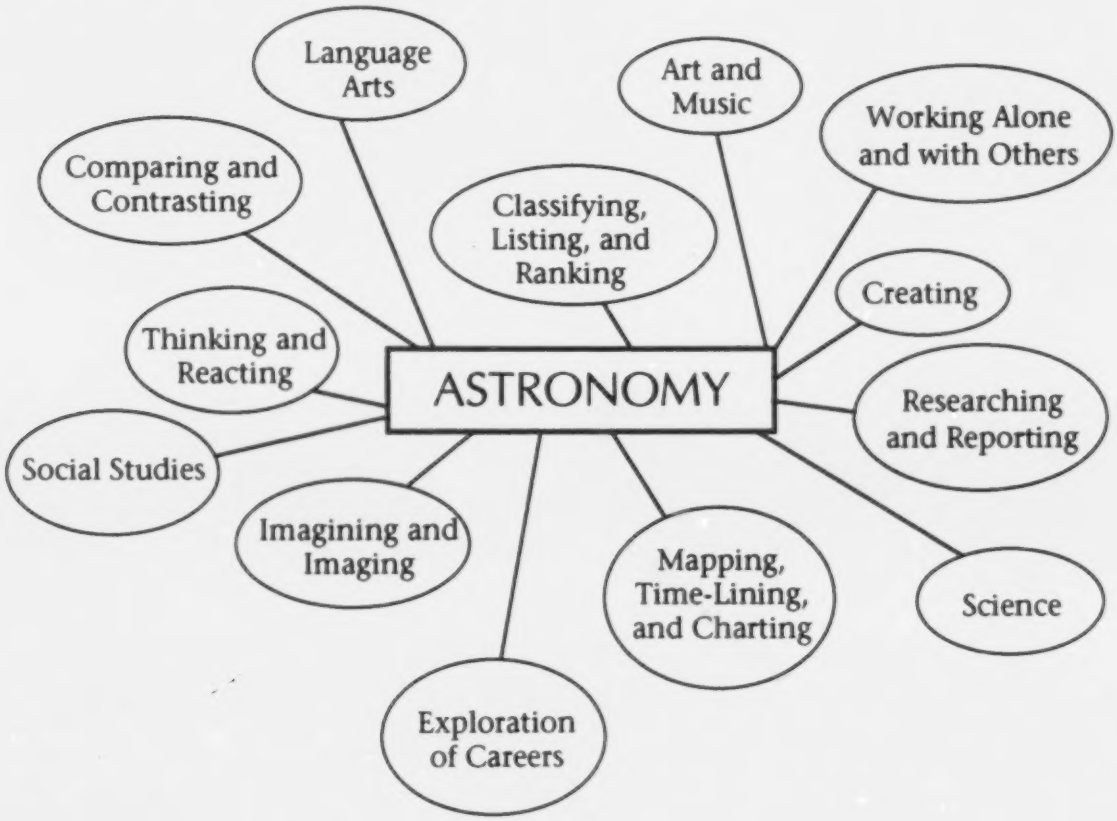
Eventually, a few students will be ready for a true investigative research study of professional quality as suggested by Joseph Renzulli in *Enrichment Triad Model: A Guide for Developing Defensible Programs for the Gifted and Talented*, 1977.

The Format

These units were originally developed for gifted students, but we now recognize that every child is gifted in one or more of the multiple intelligences. The units emphasize the use of higher-level thinking skills and are appropriate for use in any classroom where the goal is to encourage students to become responsible for their own education.

Interdisciplinary in content, each unit envelops a broad view of the topic by integrating the "basics" into each activity.

Within this book are two complete units: one created for the lower elementary student and one for the upper elementary student. Suggestions for adapting or adjusting either of the levels to fit any individual classroom are included.



SUGGESTED READINGS

Self-directed Study

Armstrong, Thomas. *In Their Own Way: Discovering and Encouraging Your Child's Personal Learning Style.* Los Angeles: J. P. Tarcher, 1988.

Brewer, Chris, and Don G. Campbell. *Rhythms of Learning: Creative Tools for Developing Lifelong Skills.* Tucson, Ariz.: Zephyr Press, 1991.

Clark, Barbara. *Optimizing Learning.* Columbus, Ohio: Merrill Publishing Company, 1986.

Gardner, Howard. *Frames of Mind: The Theory of Multiple Intelligences.* New York: Basic Books, 1985.

Kline, Peter. *The Everyday Genius: Restoring Children's Natural Joy of Learning.* Arlington, Va.: Great Ocean, 1988.

Maker, C. J. *Curriculum Development for the Gifted.* Rockville, Md.: Aspen Systems Corporation, 1982.

Malehorn, Hal. *Open to Change: Options for Teaching Self-directed Learners.* Palo Alto, Calif.: Scott Foresman and Company, 1978.

Miller, Ron. *What Are Schools For? Holistic Education in American Culture.* Brandon, Vt.: Holistic Education Press, 1990.

Purkey, William, and John Novak. *Inviting School Success: A Self-Concept Approach to Teaching and Learning.* 2d ed. Belmont, Calif.: Wadsworth Publishing Company, 1984.

Renzulli, Joseph. *Enrichment Triad Model: A Guide for Developing Defensible Programs for the Gifted and Talented.* Mansfield, Conn.: Creative Learning Press, 1977.

Stoddard, Lynn. *Redesigning Education: A Guide for Developing Human Greatness.* Tucson, Ariz.: Zephyr Press, 1991.

Udall, Anne J., and Joan E. Daniels. *Creating the Thoughtful Classroom: Strategies to Promote Student Thinking.* Tucson, Ariz.: Zephyr Press, 1991.

Getting Started

1. Select a topic as an extension of a regular subject (particularly when your class seems to crave more), or select a topic to pursue that is of particular interest and may not be a part of the curriculum. To zero in on special interests, administer an interest survey to each student.

2. Copy the unit for each student. When using these units for the entire class, you may want to expand or delete activities for individual students.

3. Set up a center in the classroom that encourages exploration in the subject field. You'll want to include a variety of materials. Be creative—the purpose of the center is to excite the students, so begin with lots of hands-on materials. Allow for ample browsing time and encourage students to investigate and become absorbed.

4. Go over each activity in the unit with the students, discussing and answering any questions. You, as teacher, are the key to successful implementation. Because most children are already well versed in the "One Right Answer" game, they will need encouragement to branch out into many of the open-ended activities in the packets.

5. Set the stage. Plan conferences and provide resources as needed. Then, get out of the way and let your students learn.

6. Give as much time as each student needs to complete each activity in the unit. The entire packet might take from five to ten weeks or longer.

7. As each activity is completed and evaluated, initial the activity near each number. You will want to evaluate on the basis of the response that is appropriate for each individual student.

8. When a student shows extreme interest in the topic, the completion of this unit might be only the beginning. This student may be ready for further study and research and may need only resources, guidance, and freedom to pursue his/her well-planned project.

Interest Development Center

ASTRONOMY

The purpose of this interest center is to stimulate interest in the topic area. Students need time for browsing and investigating for maximum benefit. To expedite the exploration process, you might make the following materials available. These are beginning ideas; you and your students will think of more. Let parents and other teachers know about the center, and it will grow without effort.

Books, Videos, Filmstrips, Photographs, Slides, and Posters

Stars, meteors, planets, asteroids
Constellations and galaxies
Greek and Roman mythology about astronomy
Star atlas
Astronautics
Space capsules, rockets, and shuttles
Space stations, satellites, robots, and probes
UFOs
Astrophysics
Space exploration
Astronauts and cosmonauts
Astronomy science projects
Astrophotography
Astrology
The Farmer's Almanac
Science fiction books about space travel
Space art

Models and Tools

Maps and globes
Telescopes
Spaceship and shuttle models

Art Supplies

Water colors
Chalk
Oil pastels
Polyform
Clay
Markers of various weights
Textures of paper

Music

The Planets by Gustav Holst
"Apollo" recording by Brian Eno
"Flight Path" and "And the Stars Go with You" recordings by John Serrie
"Galaxies" recording by Kevin Braheny
"Voyager: Grand Tour Suite" recording by Michael Lee Thomas
"Mars: The Journey Begins" and "Planets, Stars, and Galaxies" recordings by Mychael Danna
"Planetary Unfolding" recording by Michael Stearns
"Star Trek: Original TV Series Sound Effects" recording by GNP Crescendo
"Saturn's Rings" NASA Voyager II space sounds recording by Brain Mind Research, Vilano Beach, California

To Prepare for Further Research

Students will need to decide:

- What will the study be? What will be investigated and produced?
- Where will the background information be found (e.g., speaker, interviews, books, film, microfiche, documents)?
- What, exactly, will be the form of the product: a model, a manuscript, or . . . ?
- Who might be interested in the product: professionals in the field, publishers, organizations, or . . . ?
- What is needed to begin: specific plans, resources, deadlines, or . . . ?

Suggestions for Adapting the Unit to Your Particular Learning Situation

- Require fewer, or more, research sources.
- Assign more of the activities to small groups instead of to individual students.
- Give fewer or more choices.
- Delete some activities altogether.
- Arrange the unit as a class project with students choosing different parts to complete.
- Add some activities of your own.

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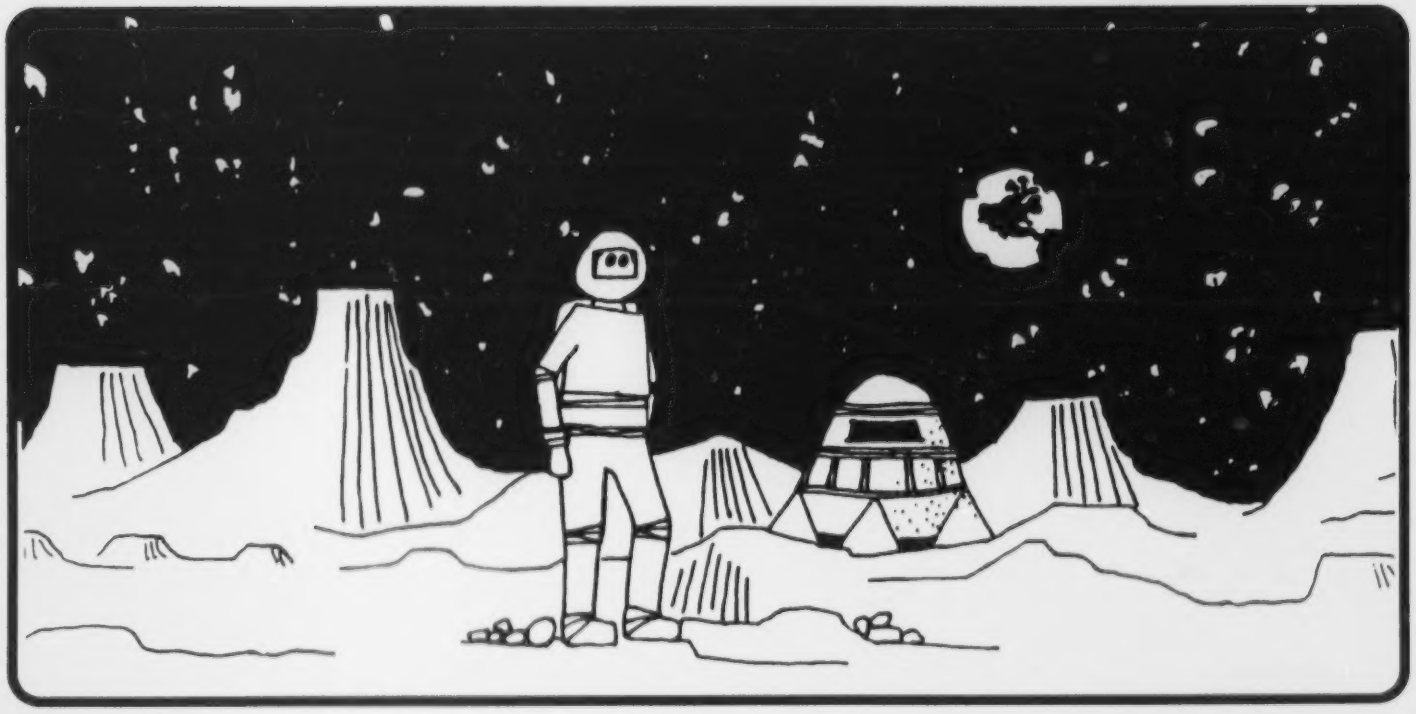

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UNIT I

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1. SETTING THE STAGE

Listen to one of the space music selections or some quiet music. Close your eyes and imagine that you are in outer space. See yourself in a spaceship that protects you from the freezing cold and airless space. Through the spaceship window you can see planet Earth as a beautiful blue pearl suspended in space.

Take a journey in your mind through our galaxy. Imagine seeing other planets and their moons, stars, and our sun. Talk about your experience with a friend.

- Draw a picture of one of your images.

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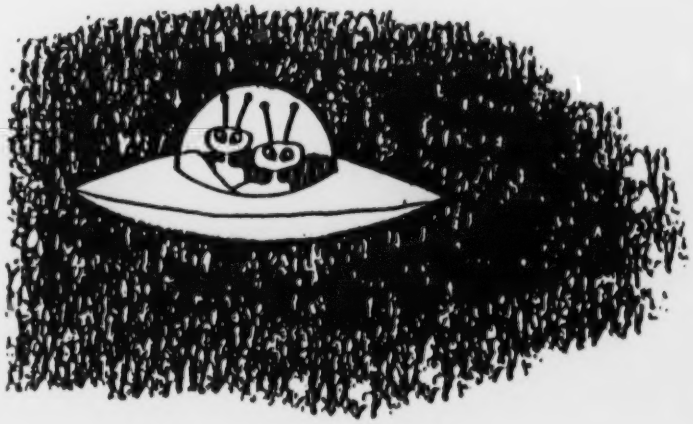
2. GO TO THE LIBRARY

Find out about:

the planets
our sun
constellations
nebulae
orbit in space
the expanding universe
space shuttles
space stations
the Apollo moon landing



Find at least three amazing facts or ideas about astronomy.

- Share these facts with the class or post them on a bulletin board.

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3. INVESTIGATE AND CREATE

Find out all you can about the Milky Way. What is it? How big is it?

- Make a mural of it. Highlight any important stars or planets.

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4. COMPARE AND CONTRAST

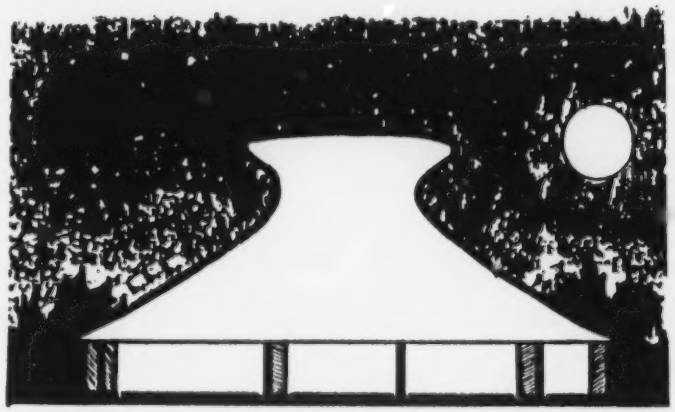
Find out about the moons of at least two planets in our solar system.

- Draw pictures or make up a song to show how they are different and how they are alike.

OR

Find some books about space stations.

- Create your own space station and make a model. Tell how yours is different from or similar to a space station in one of the books.



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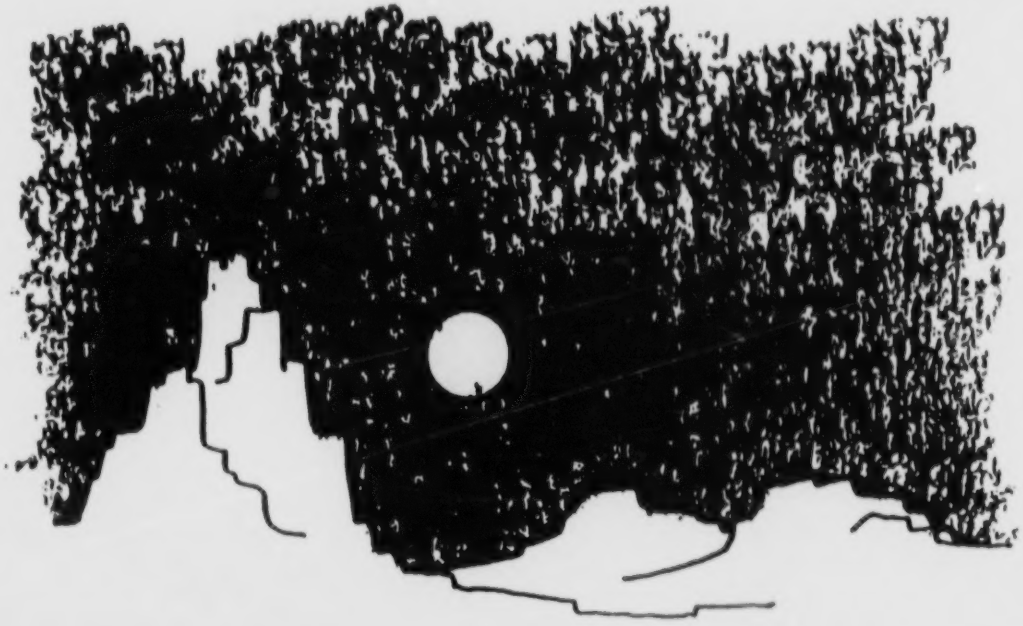
5. OUR MARVELOUS MOON

Learn about the orbit of our moon. What would happen to the moon if it left the orbit of Earth?

- Draw a picture of how you think it would look.



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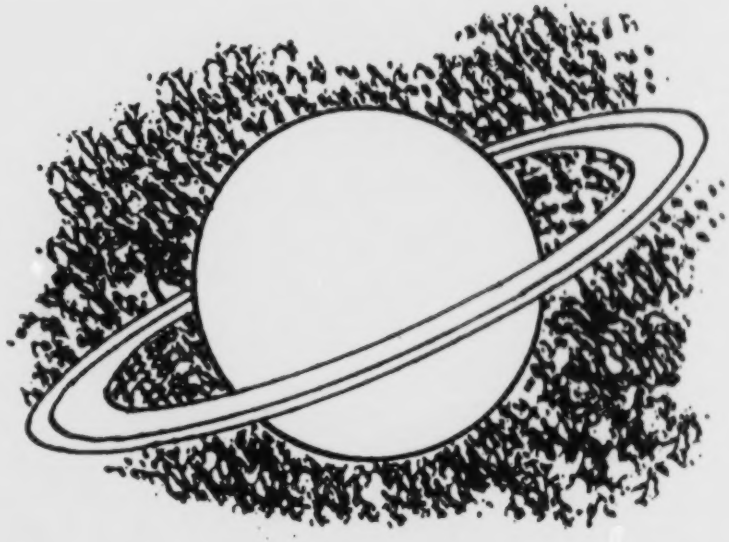
6. BEAUTIFUL RINGS

Find some pictures of Saturn. Make some guesses about its rings. What are they made of? How big are they? Look at some books to see if your guesses are right.

- Draw a picture of Saturn and label it.



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7. INVESTIGATE AND CREATE

Find out about black holes. Imagine what is in the center.

- Write a story, poem, rap, or song about black holes.

OR

Find out about the Big Dipper. Imagine that you take a trip to the Big Dipper.

- Write a news article about your trip.

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8. CRAFTS AND BUILDING

Use clay, papier-mâché, or odds and ends to

- **Build a sundial that works**

  OR

- **Build a model of a rocket**

  OR

- **Build a mobile of our solar system**

  OR

- **Build a telescope**

Display your creation with a description.

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9. USING YOUR IMAGINATION

Look at photographs of outer space. Look at paintings or drawings to see how artists have imagined space.

- Experiment with markers, oil pastels, watercolors, or acrylic paints to create your own images of outer space.

  Hang your art in the classroom or library and invite your friends to view your "Space Art Show."

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10. STARGAZING THROUGH TIME

Find out about people who studied astronomy long ago.

- Make a list or chart of their contributions to astronomy.

OR

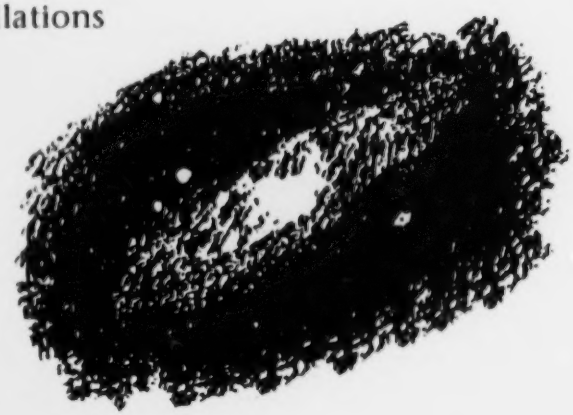
Research Greek or Roman mythology about stars.

- Draw a picture of one of the constellations and share the myth about it.

OR

Find out how Native Americans, Vikings, Pacific island cultures, and other peoples used the stars to guide them in their daily lives.

- Make a chart or mindmap showing the different ways the stars helped people.



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11. SPACE TRAVEL

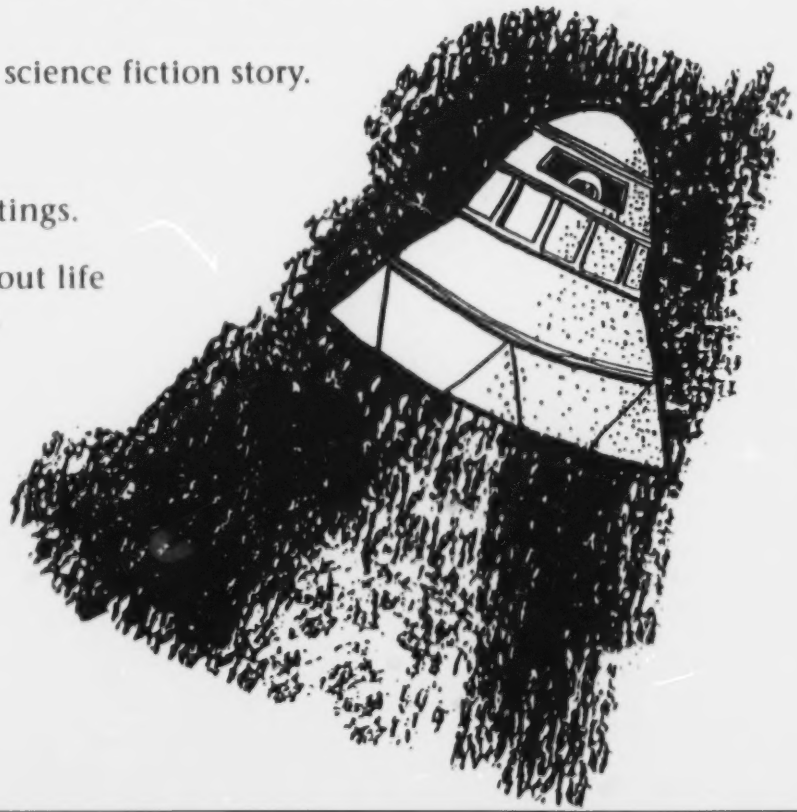
Read a short science fiction story about space travel or have someone read it to you.

- Make up your own science fiction story.

OR

Find out about UFO sightings.

- Make up a story about life from other planets.



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12. LEADING THE WAY

One small step for man, one giant leap for mankind.
—Neil Armstrong, first astronaut on the moon

Study the history of space flight.

- Make a scrapbook about astronauts.

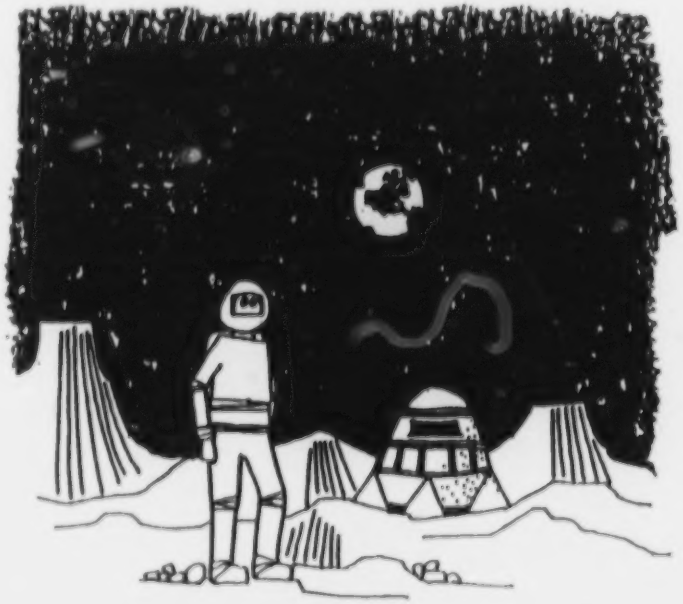
OR

Pretend you are an astronaut.

- Describe your flight to your class. Be as accurate as you can.

OR

- Make a list or collage of special items astronauts need to survive in space.



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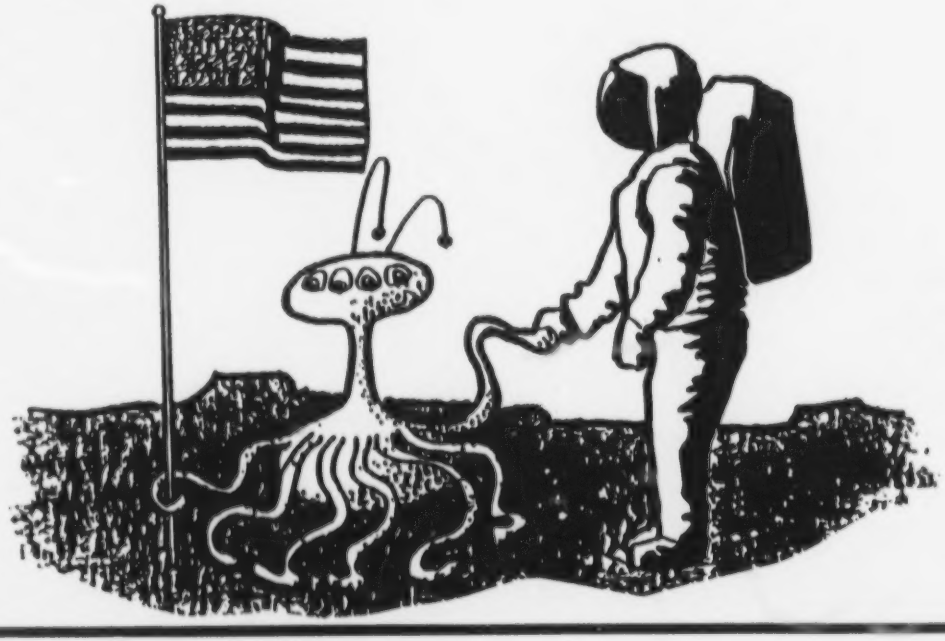
13. CAREERS IN SPACE

Invite a man or woman to talk to your class about careers that involve astronomy. Plan five questions to ask.

- Make a list of the different jobs in space exploration and research. Which would you like to do and why? Share your thoughts with a friend.



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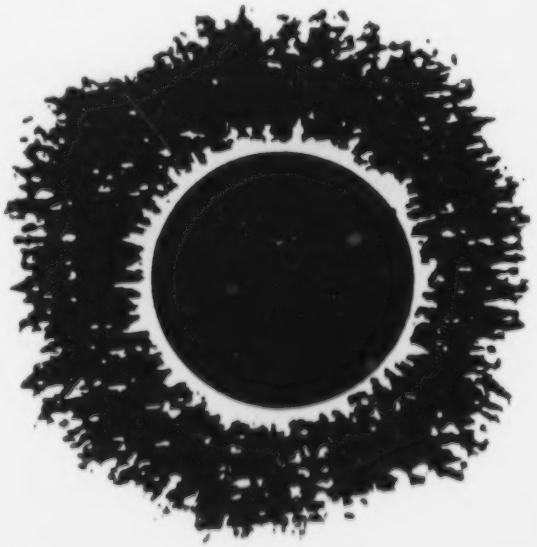
14. OUR FUTURE IN SPACE

Find out about future ideas and plans for

creating space colonies
exploring other galaxies
making space stations
manufacturing in space
tourism in space
using space robots

- Conduct a survey of five people to see what projects they think we should be doing in space. Share your survey results with your class.



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15. A NEW LANGUAGE

Down

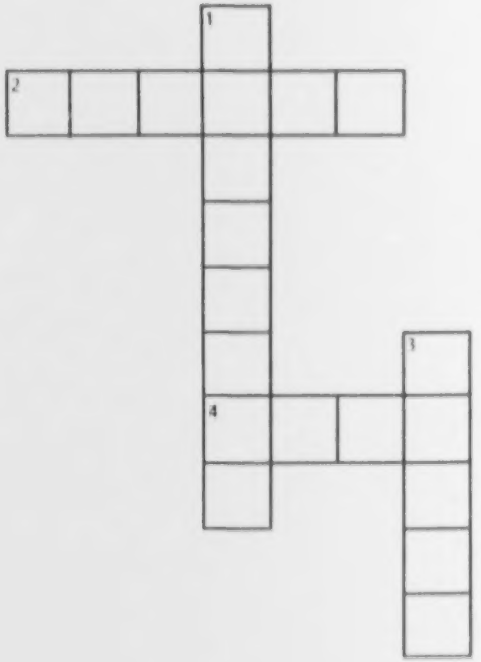
1. The cosmos

3. The path of a heavenly body

Across

2. A heavenly body that shines by reflected sunlight and revolves around the sun

4. A self-luminous heavenly body



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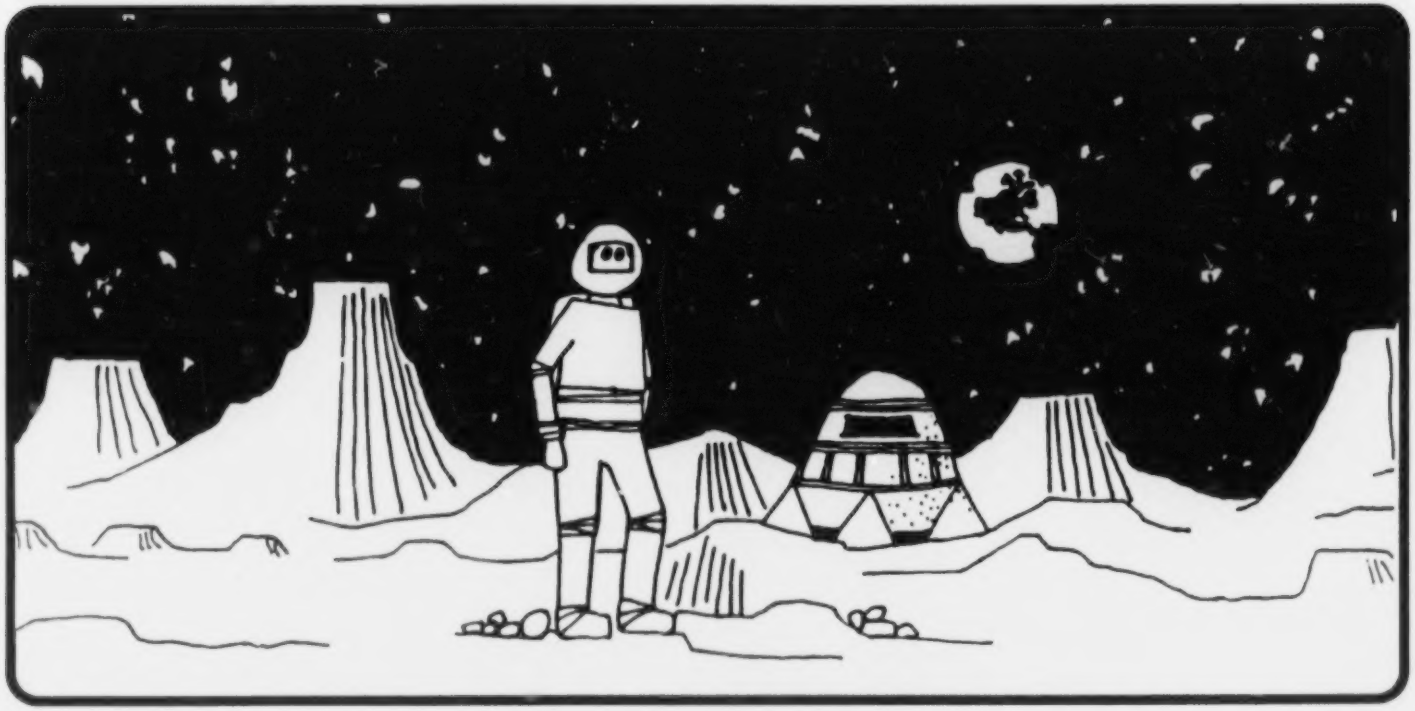

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UNIT II

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1. SETTING THE STAGE

From deep space Earth is a beautiful little planet—blue and white—set in the black emptiness of the universe with billions of bright stars as a backdrop. —Edgar Mitchell, Apollo 14 astronaut

The vast loneliness in space is awe-inspiring and it makes you realize just what you have back there on Earth. The Earth from here is a grand oasis in the big vastness of space.

—Astronaut Jim Lovell in orbit around the moon

Take some time to listen to one of the suggested space music recordings or a selection of quiet, relaxing music. Close your eyes and reflect on the astronauts' quotes. Imagine that you are in outer space, and explore the sense of wonder at seeing Earth, our moon, the stars, the universe.

- Draw or paint a picture that reflects your experience.

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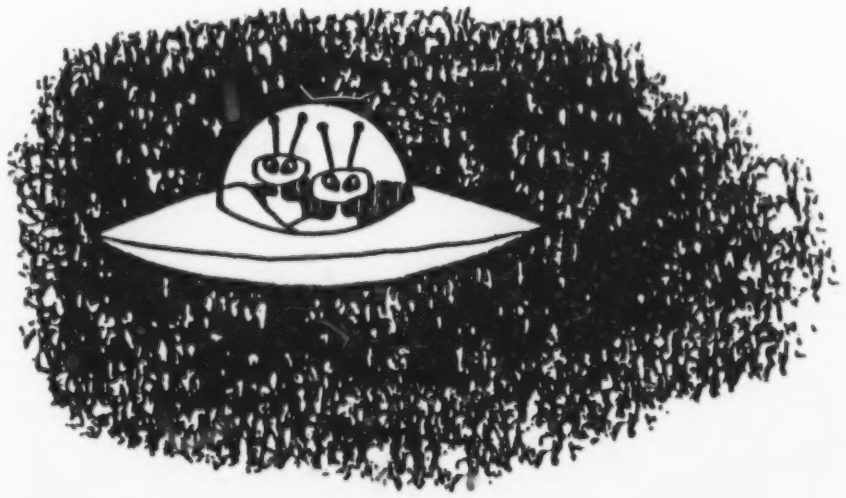
2. GO TO THE LIBRARY

Find out how the Greek scientist Eratosthenes measured the size of the Earth. How accurate was his method? Is his method useful today?

- Explain your findings in a written or an oral report.



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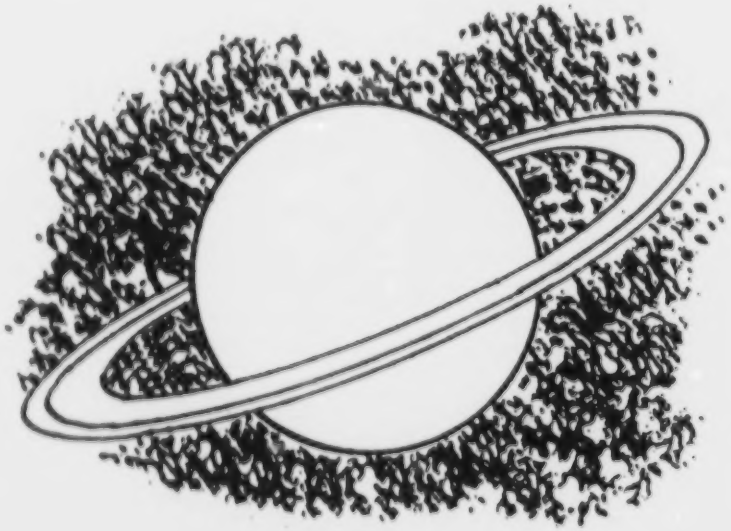
3. SPECTACULAR SATURN

Find out about the most recent discoveries related to Saturn and its rings. What are they made of? How large are they? How did they form?

- In a drawing, painting, or story show your findings.



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4. RESEARCH AND REPORT

Research and report on one of the following:

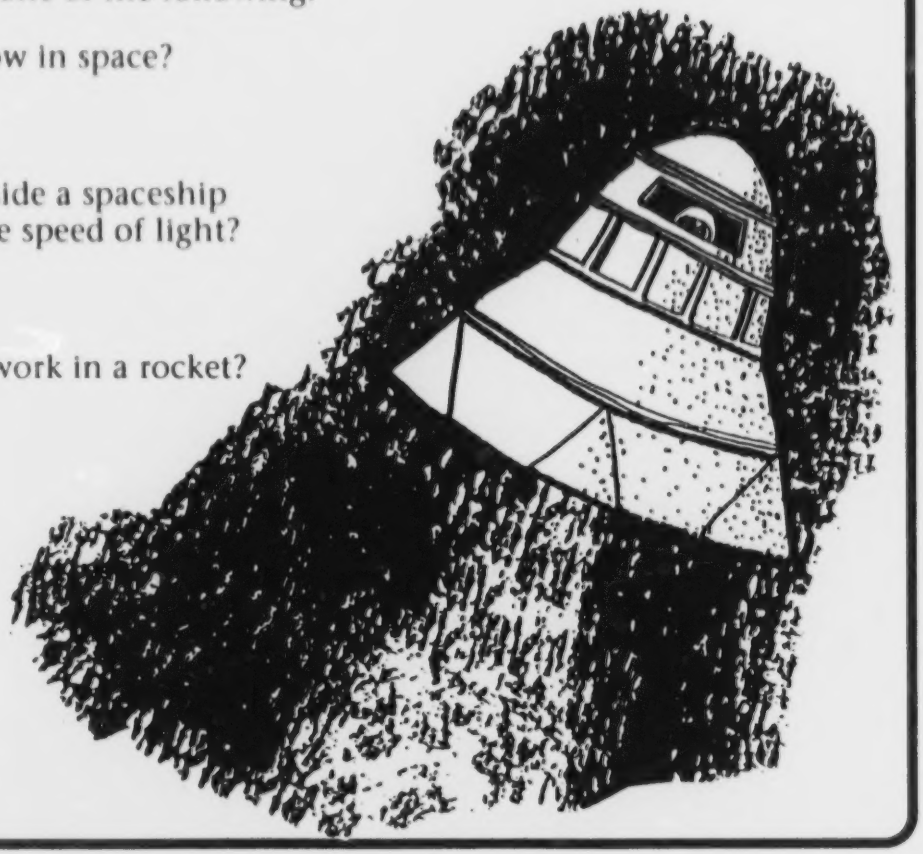
- Does the wind blow in space?

  OR

- What happens inside a spaceship going as fast as the speed of light?

  OR

- How does fusion work in a rocket?



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5. OUR INCREDIBLE SUN

Think about the sunlight you can see today. When was it actually emitted from the sun?

How long would it take a spaceship to travel to the sun?

How hot is our sun?

- Make a crossword puzzle or game that includes facts about the sun. If you like, include other facts about our solar system.

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6. A WORLD OF LITERATURE

Read John Milton's description of our solar system in *Paradise Lost*. Find two other descriptions of our solar system or galaxy and compare them with Milton's vision.

- Write your own poem or short story about our solar system or our galaxy.

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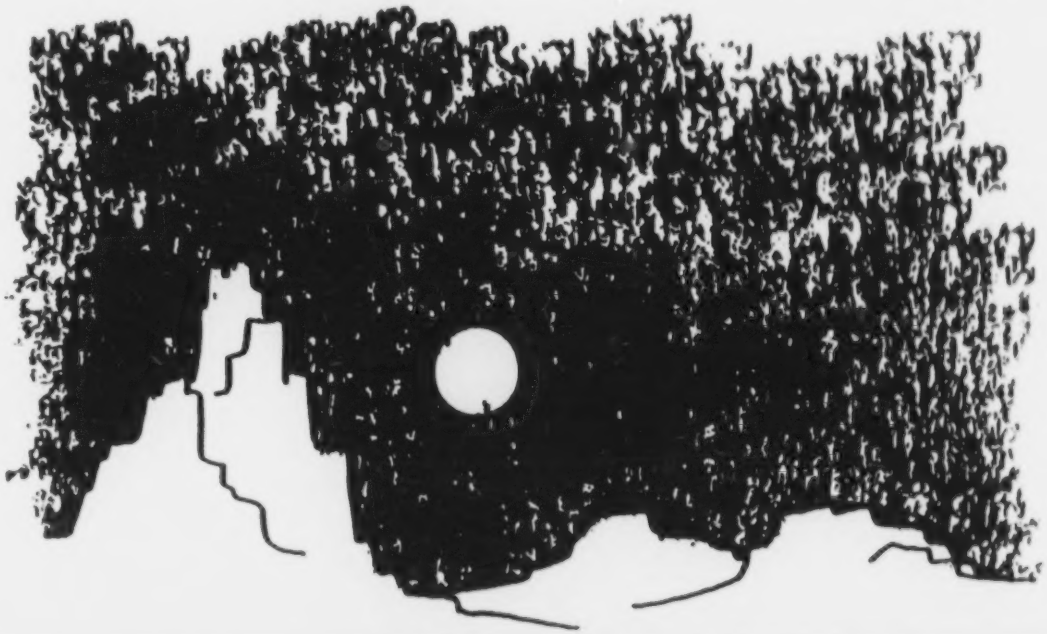
7. OUR MARVELOUS MOON

Find out about our moon and its orbit. What would happen if our moon left the orbit of Earth?

Pretend you are a news reporter on TV.

- Give a newscast reporting the events you think would happen.



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8. SPACE CONNECTIONS

It is a bad (though well-rewarded) habit of some academics to teach their own subject as if it had nothing to do with others. It is precisely by seeing the connections between the fields, however, that one becomes educated.
—Gerald Holton

Consider study in some of the following areas. Choose five of these fields and explain how they could be related to astronomy.

Anthropology
Archaeology
Ecology
Energy
Engineering
Law
Literature
Meteorology
Molecular biology
Philosophy
Psychology

- Add five more related subjects to the list.

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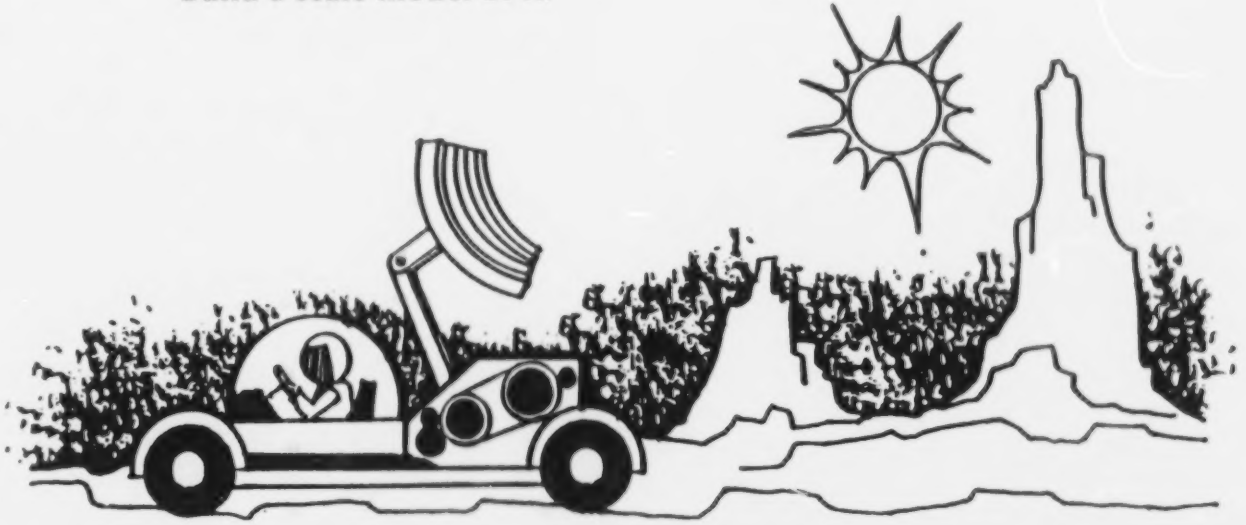
9. INVESTIGATE AND CREATE

CHOOSE ONE:

- Map our galaxy and place our sun in it.
- Make a scale drawing of the orbit of the planets on a large poster board or in a mobile.
- Invent a solar-powered vehicle for transportation on the moon. Build a scale model of it.



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10. THE HISTORY OF ASTRONOMY

Find out about the study of astronomy throughout history. What are some of the ideas about our solar system that have changed over time?

- Make a time line showing the improvements in the telescope and the discoveries of planetary bodies.

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11. JOURNEY TO THE UNKNOWN

Research the planets in our solar system.

- Design a "Three-Planet Tour: Destination Pluto" with some of your friends.

OR

Study black holes. Imagine what might be in the center of these phenomena.

- Write an imaginary story, poem, rap, or song about them.

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12. TIME AND SPACE

Measure the longitude and latitude of the location of your school and one other place you know.

- Chart your findings.

OR

Investigate the different ways people have kept time. How is the International Date Line related to time? How wide is a time zone?

- Use a plastic dome and show the time zones of Earth. Make up a quiz for your friends asking, "What time is it in (fill in a city) if it's (fill in a time) in (fill in a second city)?

OR

- Illustrate the yearly changes in the path of the sun's rays. Draw a diagram of the sun's path across the sky. Compare the sun's position on June 21, December 21, and March 21.

OR

What is the difference between gravity and magnetism?

- Prepare a scientific experiment to show these differences.

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13. CRAFTS AND BUILDING

Use clay, papier-mâché, or odds and ends to

- **Build a sundial that works**

  OR

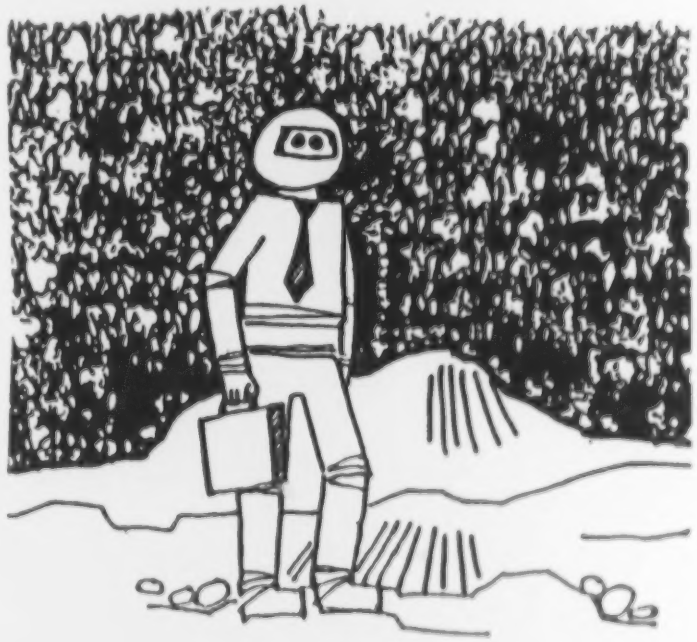
- **Build a model rocket**

  OR

- **Build a refractor or reflector telescope (try it out at night!)**

  OR

- **Build a planetarium showing the stars in the winter sky**



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14. USING YOUR CREATIVITY

Look at photographs of outer space and explore artists' imaginary drawings of space.

- Experiment with creating your own images of outer space with markers, oil pastels, watercolor paints, or acrylic paints. Create a "Space Art Show" and invite another class to see it.

OR

The Astronomical Society of the Pacific has bumper stickers such as "Supernovae Are a Blast."

- Create three of your own astronomical bumper stickers.

OR

- Create a game that teaches the players about our solar system and our galaxy.

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15. MORE CREATIVE ACTIVITIES

- Create a constellation show by pricking holes into color slides and projecting the slides onto a screen. Add appropriate music.

OR

- Take photographs of the night sky using black-and-white film. Create a bulletin board display of your pictures.

OR

Look at Vincent van Gogh's *The Starry Night* and find ten words to describe his interpretation.

- Make your own painting that illustrates how you feel about a starry night.

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16. COMPARE AND CONTRAST

CONTRAST the center of Earth with the center of Saturn.

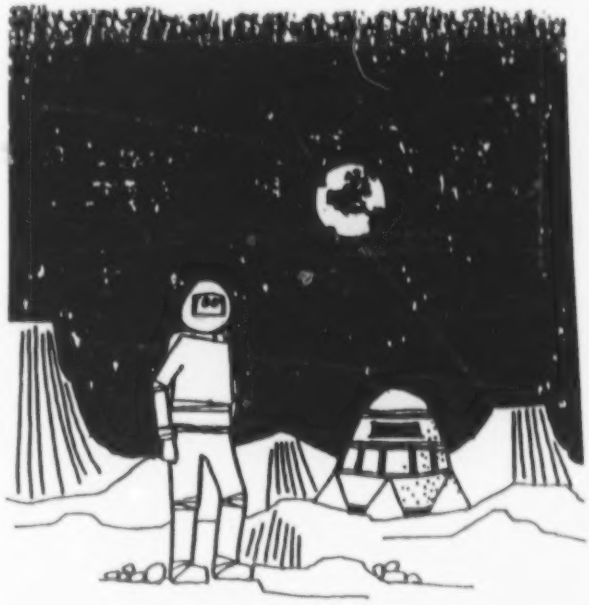
OR

CONTRAST AND COMPARE two popular types of telescopes.

OR

COMPARE the "terrestrial" planets and the "giant" planets in our solar system.

- Chart your findings.



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17. MORE COMPARE AND CONTRAST

COMPARE AND CONTRAST a solar and a lunar eclipse.

OR

COMPARE your weight on Earth with your weight on the moon, on Mars, or on Saturn. Do the same for the weight of three other people.

OR

COMPARE the similarities and differences of the moons in our solar system.

- Chart your findings.

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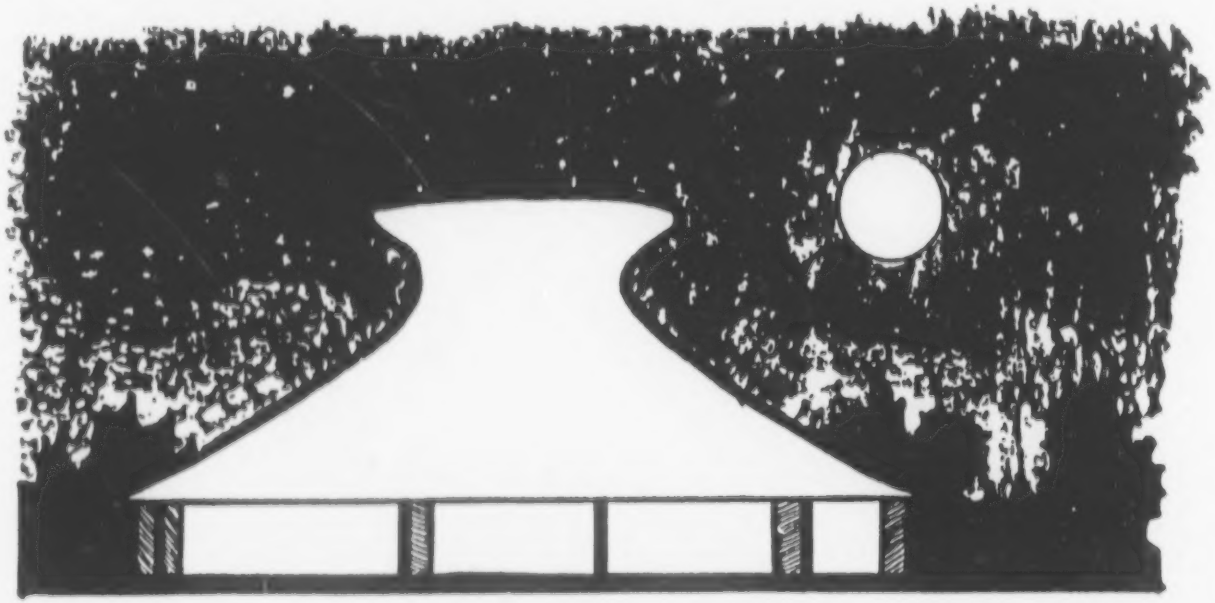
18. STARGAZING THROUGH TIME

Find out about people who studied astronomy years ago. What contributions did Bessel, Galileo, Kepler, Newton, and Ptolemy make?

- Make a chart showing their discoveries and add the names and contributions of five other astronomers.



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19. ANCIENT ASTRONOMY

Research Greek or Roman mythology about stars. Study one of the constellation myths.

- Draw a picture of it and write a scientific description of the celestial bodies that make up the constellation.

OR

Find out how ancient peoples read the night sky to

navigate
plant crops
keep track of time

- Write a report that explains how ancient peoples interpreted the position of the stars to help them.

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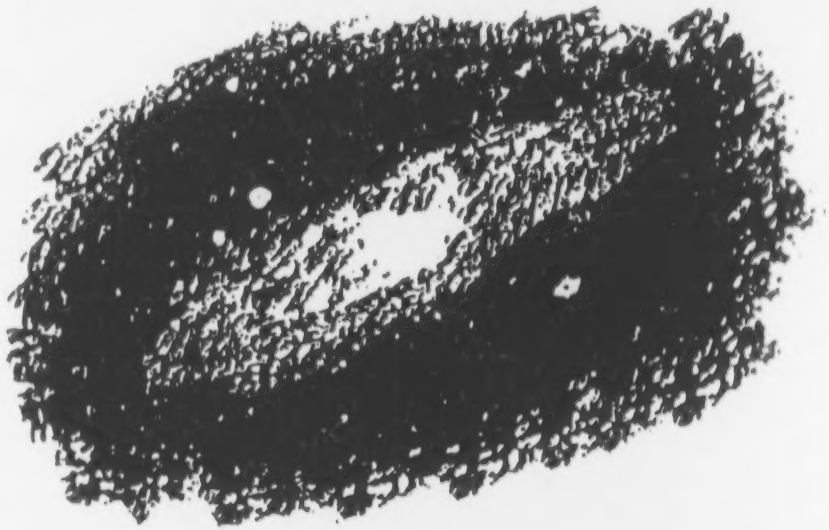
20. NEW VIEWS

Explore the big bang and expanding universe theories. How have these ideas changed our views of Earth and the beginning of the universe?

- In a chart, diagram, or essay, compare these current views of the origin of the universe with the theories of the 1800s.



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21. LEADING THE WAY

One small step for man, one giant leap for mankind.
—Neil Armstrong, first astronaut on the moon

CHOOSE ONE:

Explore the history of spaceflight.

- Make a time line from the first satellite in space to the first man on the moon.

Find out about the lives of women who have been pioneers in space exploration.

- Write a biography of one of them.

Investigate the lives of some of the astronauts. What similarities and differences can you find in their childhoods, interests, and skills?

- Make a chart of these similarities and differences.

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22. MORE LEADERS

CHOOSE ONE:

Research at least two of the "founding fathers" of space flight.

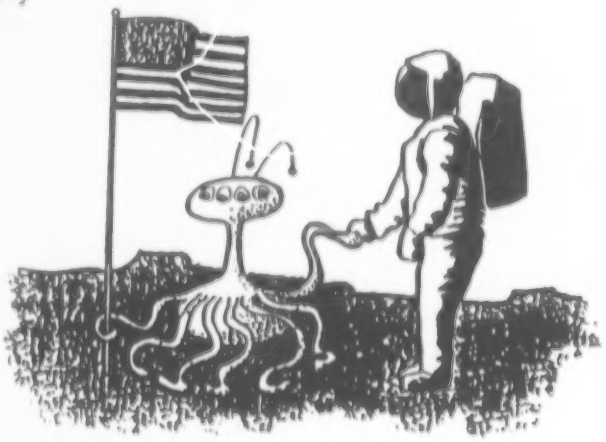
- Make a list of their contributions.

What contributions have twentieth-century scientists Edwin Hubble and Stephen Hawking made to astronomy?

- Write a newspaper article about their discoveries.

Research the space programs of the United States and Russia.

- In a chart or an essay report on their similarities and differences.



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23. CAREERS IN SPACE

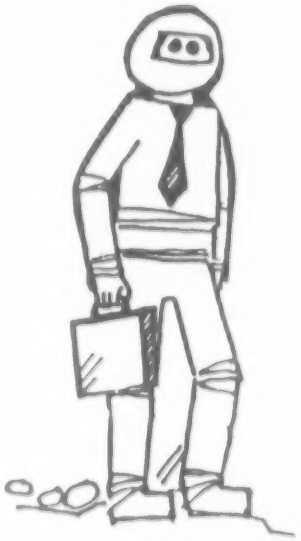
- Organize a Careers in Space Week. Plan speakers, films, field trips, and other activities.

OR

- With a friend, prepare a mock TV interview with the following people:

Dr. Konstantin Twiolkowski
Dr. Robert Goddard
Dr. Wernher von Braun
Dr. Eugene Sanger
Dr. Stephen Hawking

Plan a minimum of eight questions for each person. Share the interview with your class.



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24. PLANETARY CITIZENS

No man I know of has gone to the moon that has not been affected in some way by this view of the universe. It is what I prefer to call instant global consciousness. Each man comes back with a feeling that he is no longer only an American citizen; he is a planetary citizen. He doesn't like things the way they are, and he wants to improve them.

—Edgar Mitchell

Imagine looking back on a colorful sphere silhouetted against the black vastness of space. You see no boundaries between nations . . . no races . . . no different religions . . . no opposite political philosophies.

—astronaut Jack Swigert while circling the moon

Views of the earth from space have shown us how small and fragile our home planet truly is. Perhaps ultimately men of all nations will work together in space . . . and through their activities help humanity unite in peace on its planet Earth. —President Richard Nixon

Reflect for a moment on these thoughts inspired by the view of Earth from space. Think of yourself as a planetary citizen.

- Make a list of the things you would like to change to make the planet a better place for all people to live.

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25. THE FUTURE

CHOOSE TWO:

- Organize a class debate on "Which planet could be colonized in the twenty-first century?"
- Investigate space stations and design one for the future.
- Make a list of products that could be manufactured in space. Write a short paper that explains the benefits and drawbacks of space manufacturing.
- Conduct a survey of at least ten people and ask them whether or not they feel we should be conducting outer-space exploration to remote planets or other galaxies. Compile your results and share them with your class.
- Find out about the possibility of a tourist industry in space. Design a tour of the moon and create an advertisement for it.

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26. A NEW LANGUAGE

- Write or draw descriptions of *five* of these words on cards and post them on the bulletin board.

parallax
interstellar matter
eclipse
galaxy
Kohoutek
pulsar
sphere
quasar
planetarium
space shuttle
astrophysical laboratory
quark
supernova
terrestrial astronomer
cosmologist
big bang
red giant
Cepheid
blue straggler
Great Andromeda Spiral
Crab Nebula

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27. PUZZLES

1. What is a light year? Find out how fast this is in both miles and kilometers per second, per minute, per hour, per day, and per year.

2. Two rocket ships take off at the same moment. One travels from the moon toward Earth at 18,000 miles per hour, and the other travels from Earth toward the moon at 24,000 miles per hour. How far apart are the two rocket ships one minute before they pass each other?

3. What do you know about tides? A large yacht has a twelve-foot rope ladder hanging over the side. The rungs are one foot apart. The bottom rung is touching the water. The tide is rising at a rate of six inches per hour. When will the first three rungs of the ladder be covered with water?

4. Inertia is a problem astronauts must deal with in space. What is inertia? Name two or three ways to empty a glass of water in space.

5. If you lost your oars from a rowboat and you had a rope, how could you get your boat to move to the shore? When you have solved this puzzle, find out if the same principle applies on a spaceship stranded in outer space.

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EXPLORING THE ARTS

An opportunity to integrate art experiences within an academic content area

BY STEPHANY MACK

While each component—the Self-directed Learning Units and Exploring the Arts—is a complete and valid learning experience in itself, together they provide a more comprehensive and lasting educational experience for the learner.

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ART SUPPLEMENT

The Starry Night by Vincent van Gogh, Dutch artist 1853–1890

Vincent van Gogh's work is familiar to a wider audience today than the work of any other single painter.

LOOK at *The Starry Night.* It seems to explode, race, and burst, but it does not run away. It is built on a great rushing movement from left to right.

DESCRIBE *The Starry Night.* Discuss

color	**subject matter**
texture	**directional force**
space	**attention to detail**
line quality	**emotional impact**

COMPILE a list of ten words that describe the movement and energy in *The Starry Night.*

READ about the life of Vincent van Gogh. Make an outline of the major events of his life. Make a list of vocabulary words that describe Vincent van Gogh and his life's work. Using a marking pen, write each word on the front and back of a piece of colored board. Make a mobile with your cards.

(continued on next page)

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ART SUPPLEMENT *(continued)*

After reading about Vincent van Gogh's life, see if you can find any of his personality traits expressed in *The Starry Night.*

DO a painting of a starry night. Express your own personal feelings through this painting.

After you have completed your painting, look at your composition. Is it balanced? Does it express your feelings? Do the colors "speak" to you? Is your composition interesting? Why?

EXPRESS the same idea with torn paper. Use colored construction paper for the background. Tear other colored papers to construct another starry night.

COMPARE AND CONTRAST your two compositions. Discuss the similarities and differences between them. How does using different art media change the feelings of a design? Discuss your artwork with others.

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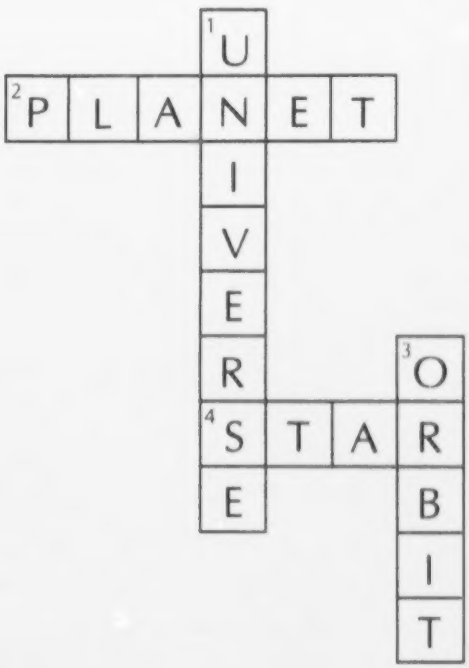
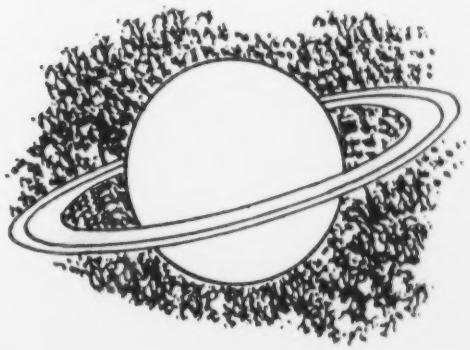
Appendix

A NEW LANGUAGE (UNIT I, #15)

Crossword Puzzle Key





Down

1. The cosmos
3. The path of a heavenly body

Across

2. A heavenly body that shines by reflected sunlight and revolves around the sun
4. A self-luminous heavenly body

PUZZLES KEY (UNIT II, #27)

1. 186,000 miles per second
   186,000 x 60 = miles per minute
   miles per minute x 60 = miles per hour
   miles per hour x 24 = miles per day
   miles per day x 365 = miles per year

   OR

   300,000 kilometers per second
   300,000 x 60 = km per minute
   km per minute x 60 = km per hour
   km per hour x 24 = km per day
   km per day x 365 = km per year

2. They are 700 miles apart one minute before passing.

3. They will never be covered, because as the tide rises the yacht also rises. Therefore, the water never rises higher than the first rung of the ladder.

4. Hold the glass still, then jerk it quickly downward. The water will remain in place after the glass is moved.

   OR

   Swing the glass around in a circular motion. Centrifugal force will propel the water out of the glass.

5. Attach the rope to the back of the boat and jerk it back and forth. This will make the boat rock, and the rocking motion will cause the boat to slowly begin to move.

   In a rocket ship there is no friction. The only way to move an object is by a thrust action, such as gas propulsion.

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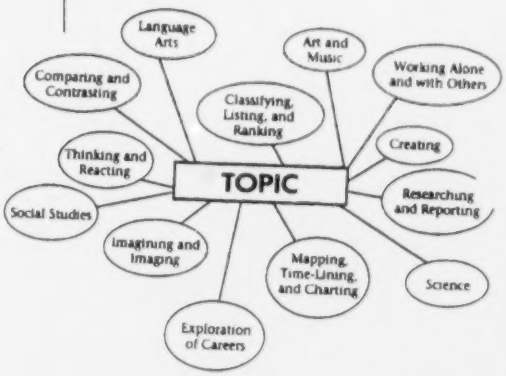

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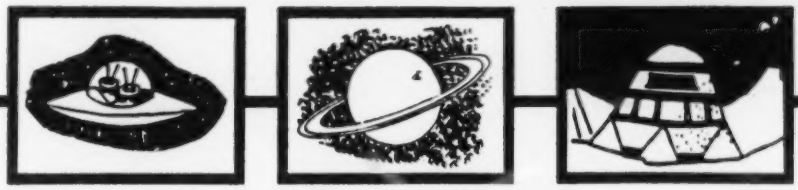

ASTRONOMY

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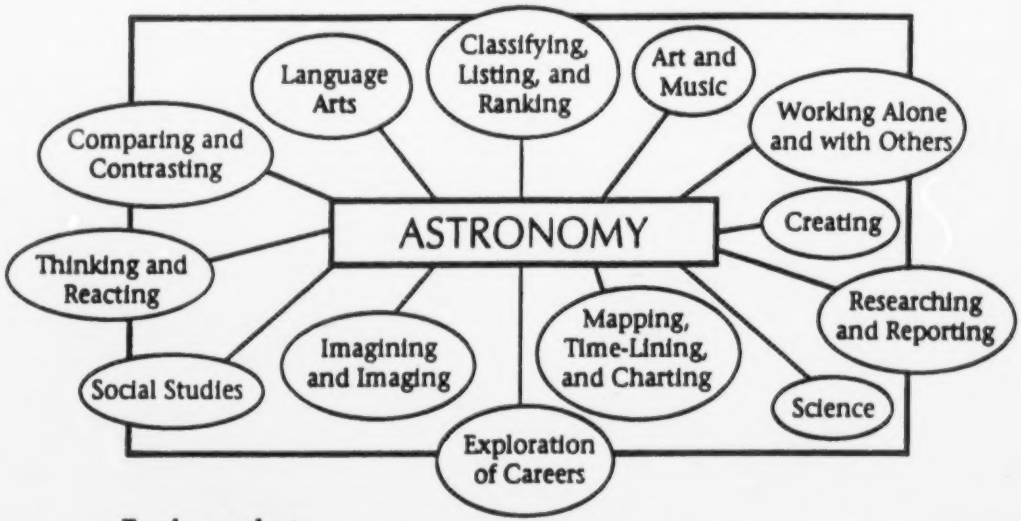

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